U.S. PATENT APPLICATION

for

COMPUTER SYSTEM FOR DETERMINING A CUSTOMIZED ANIMAL FEED

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COMPUTER SYSTEM FOR DETERMINING A CUSTOMIZED ANIMAL FEED

Cross Reference to Related Patent Applications

[0001] This application is a continuation of Application No. 09/739,550 filed December 15, 2000.

Field Of The Invention

[0002] The present invention relates to a computerized system for determining a customized feed for animals, such as cattle, swine, poultry, fish, crustaceans and the like. In particular, the system determines a feed mix based upon data relating to information such as animal characteristics, available ingredients, speed of product production, and cost of production.

Background

[0003] In food production, and specifically producing animal products such as milk, beef, pork, eggs, chicken, fish etc., there is need to improve production efficiency. Production efficiency, i.e. producing the maximum quantity of animal products while minimizing the time and cost of production for those products, is important in maintaining a competitive advantage.

[0004] A producer (i.e. a farmer, rancher, pork producer, and the like) generally wants to maximize the amount of animal product produced (e.g. gallons of milk, pounds of beef or pork produced) while keeping the costs associated with feed at a low level in order to achieve maximum animal productivity. The maximized amount of animal product should be produced at a minimized cost to the producer. Costs to the producer include the cost of feed needed to produce the animal products, as well as the costs of related equipment and facilities needed in the production of animal products. In order to minimize the effect of fixed costs associated with equipment and facilities, the maximum amount of animal product should preferably be produced in a minimum time period.

[0005] Producers are constantly trying to increase these production efficiencies. One way of increasing production efficiencies is by altering the feed which animals are fed. For example, a feed with certain amounts of nutrients can cause an animal to grow or produce animal products quickly and/or perform better, whereas a different feed with different amounts of nutrients may cause an animal to grow or produce animal products on a more cost effective basis.

[0006] Current systems for creating animal feed are not fully capable of helping producers evaluate and improve production efficiencies. Current systems commonly generate an overall nutrient profile which is related to a set of animal characteristics. Such systems then look at the overall nutrient profile and compare what nutrients may be had from the on-farm ingredients. From this comparison, a "nutritional gap" can be calculated, i.e., the nutritional requirements that the producer needs to fulfill his production goals after accounting for the use of his on-site feed. This nutritional gap is then compared to the nutritional components which may be available from ingredients located at a supplier's mill. Through a comparison of the nutritional gap and the nutritional components available from the mill, current systems allow a supplier to provide a cost effective custom feed which is optimized to permit an animal to produce desired animal products on a cost minimized basis.

[0007] Currently systems exist that are capable of taking the amounts of on-farm ingredients to be used in the overall diet of the animal into account. This is typically done by accounting for the on-farm component of the animal's diet as a fixed input parameter in the determination. It would be advantageous to be able to modify the amounts of on-farm ingredients to be used in forming the custom feed as part of the optimization process. Moreover, current systems are generally limited to generating the custom feed based on a single evaluation criteria, typically based on the cost of the feed (e.g., on a cost of feed per unit of animal weight gain basis). It would be advantageous to have a system which is capable of utilizing more than one evaluation criteria in generating the custom feed.

Summary

One embodiment of the present invention provides a system for determining customized feed for animals, such as farm livestock, poultry, fish and crustaceans. The system stores animal data representative of the characteristics of the animal, feed data representative of the feed ingredients located at one or more locations, and evaluation data representative of at least one evaluation criteria. The evaluation criteria are generally related to factors representative of animal productivity. Examples of evaluation criteria include (i) animal production rate (e.g., the rate of animal weight gain or the rate of production of a food product such as milk or eggs); (ii) cost of feed per unit animal weight gain; and (iii) feed weight per unit animal weight gain. The system includes a data processing circuit, which may be one or more programmed microprocessors, in communication with a data storage device or devices which store the data. The data processing circuit is configured to generate profile data representative of a nutrient profile for the animals based upon the animal data. In effect, the nutrient profile is a description of the overall diet to be fed to the animals defined in terms of a set of nutritional parameters ("nutrients"). Using the profile data, the data processing circuit generates ration data representative of a combination of ingredients from one or more locations. The ration data is generated by the data processing circuit based upon the profile data, the feed data and the evaluation data.

[0009] Another embodiment of the system includes processing means for generating the profile data representative of a nutrient profile for the animals based upon the animal data. Using the profile data the data processing means generates ration data representative of a combination of ingredients from one or more locations. The ration data is generated by the data processing means based upon the profile data, the feed data and the evaluation data.

[0010] Another embodiment of the present invention provides a method for determining customized feed for one or more animals. The method includes storing animal data representative of the characteristics of the animal, storing feed data representative of the feed ingredients located a first location (e.g., on farm), storing second feed data representative of

the feed ingredients located at a second location (e.g., at a supplier's mill), and storing evaluation data representative of one or more evaluation criteria. Profile data representative of a nutrient profile for the animal is generated based upon the animal data. Using the profile data, ration data representative of a combination of ingredients from one or more locations is generated based upon the profile data, feed data and evaluation data.

[0011] Another embodiment of the present invention provides customized feed produced by a process. The process includes storing animal data representative of the characteristics of the animal, feed data representative of the feed ingredients located a location, storing second feed data representative of the feed ingredients located at a second location, and storing evaluation data representative of at least one evaluation criteria. Profile data representative of a nutrient profile for the animal is generated based upon the animal data. Using the profile data, ration data representative of a combination of ingredients from the location is generated based further upon feed data and the evaluation data.

[0012] A further embodiment of the present invention provides a food product produced from an animal fed a customized feed. The food product is produced by a method which includes storing animal data representative of the characteristics of the animal, feed data representative of the feed ingredients located at a location, storing second feed data representative of the feed ingredients located at one or more additional locations, and storing evaluation data representative of at least one evaluation criteria. Profile data representative of a nutrient profile for the animal can be generated based upon the animal data. Using the profile data, ration data representative of a combination of ingredients from one or more of the locations is generated based further upon the feed data and evaluation data. The combination of ingredients is fed to the animal and the animal is appropriately processed to produce the desired food (e.g., a food product such as milk or eggs may be recovered from the animal or the animal may be slaughtered to provide meat for consumption by humans and/or other animals).

[0013] As modifications to the embodiments described herein, systems and/or methods may rely on more than one optimizing criteria and/or feed data representative of ingredients located at more than one location. For example, ingredients which could be used to create the

ration may be located at the farm associated with the animals as well as at the mill of an ingredient supplier. Depending upon the requirements of the system, processing can be consolidated in one processor or divided between processors in communication via a network such as a LAN or the Internet. Furthermore, the processors may be located in devices such as workstations, portable PC's and/or hand held computers.

[0014] In other variations of the embodiments described herein, the systems and/or methods may further include a memory portion in communication with the digital processor which stores variation data representative of a range for one or more nutrients of the nutrient profile. The digital processor is capable of generating a set of ration data based upon the variation data. A memory portion of the system may store variation data which corresponds to preselected incremental variations for the values assigned to one or more individual nutrients in the nutritional profile.

[0015] Throughout this application, the text refers to various embodiments of the system and/or method. The various embodiments described are meant to provide a variety of exemplary examples and should not be construed as descriptions of alternative species. Moreover, it should be noted that the descriptions of the various embodiments provided herein may be of overlapping scope. The embodiments discussed herein are merely illustrative and are not meant to limit the scope of the present invention.

Brief Description Of The Drawings

[0016] Figure 1 is a general schematic representation of the data flow in one embodiment of the present System.

[0017] Figure 2 is a general schematic representation of the data flow in another embodiment of the System which is designed to be used to generate a custom product ("Custom Ration") and/or feed mix from on-site ingredients ("On-Farm Ration") optimized for milk production and/or quality.

[0018] Figure 3 is a general schematic representation of the data flow in a variation of the System shown in Figure 1.

Detailed Description

[0019] An exemplary system, and process which can be used in producing a customized feed for animals, such as livestock, poultry, fish or crustaceans is described herein. How the system and process can increase production efficiencies by customizing feed is also disclosed. It is particularly desirable if the system and methods are capable of determining an optimized feed using one or more evaluation criteria. Examples of suitable evaluation criteria include a feed cost per unit animal weight gain basis, an animal production rate basis (e.g., based upon a rate of animal weight gain or a rate of production of an animal product, such as milk or eggs), and a feed amount per unit of animal weight gain basis.

[0020] In one embodiment of the present system, a computer system may be used which has a processing unit that executes sequences of instructions contained in memory. More specifically, execution of the sequences of instructions causes the processing unit to perform various operations, which are described herein. The instructions may be loaded into a random access memory (RAM) for execution by the processing unit from a read-only memory (ROM), a mass storage device, or some other persistent storage. In other embodiments, hardwired circuitry may be used in place of, or in combination with, software instructions to implement the present method. Thus, the embodiments described herein are not limited to any specific combination of hardware circuitry and/or software, nor to any particular source for the instructions executed by the computer system.

[0021] Creating a customized feed typically involves processing and manipulating at least four basic data sets (see, e.g., Figure 1): first feed data representative of the collection of ingredients located at a first location 1, second feed data representative of the collection ingredients located at a second location 2, animal data representative of characteristics of the animal 3 (e.g., parameters related to its genotype, production level, environment and/or feeding regime), and evaluation criteria 4. As will be explained below, very often first and second feed data representative of sets of ingredients located at an on-farm site (first

ingredients 1 located at a first location) and ingredients located at a supplier's mill site (second ingredients 2 located at a second location) are used to generate the recommended mix of ingredients to be fed to the animal. In many instances, the ration data define an overall diet for the animal which includes custom rations from more than one location (e.g., a custom ration from a first location 7 and a custom ration from a second location 8 as depicted in Figure 1). These can be combined to create a customized feed ("ration") which fulfills the animal data requirements while meeting the evaluation criteria 4.

[0022] The evaluation criteria may be chosen from such suitable criteria related to animal productivity as (i) animal production rate, (ii) cost of feed per unit animal weight gain, and (iii) feed weight per unit animal weight gain.

In some modified embodiments, the present system may include additional memory portions for storing nutrient level constraints 5 and/or ingredient level constraints 6. This may be useful where, for example, it has been established that higher levels of certain nutritional components could pose a risk to the health of an animal being fed the custom feed. For example, if the custom feed includes some trace minerals, such as selenium, present in too great an amount, the custom feed may have adverse health consequences to the animal. Various embodiments of the present invention allow constraints to be placed on the maximum and/or minimum amounts of one or more nutrients in the profile data generated. In some embodiments, this may be used together with the animal data as a basis to calculate the profile data. These constraints may be stored in a memory location as part of the system or the system may permit an individual operator to input one or more constraints on the amount of particular nutrient(s) in the profile data generated by the system. Similarly, it may be desirable to limit the amounts of one or more ingredients in either a custom product mix or in the overall diet to be fed to the animal. For example, for ease of formulation of a custom feed in pellet form it may be desirable to limit the amount of certain ingredients and/or require the inclusion of minimum amounts of specified ingredients.

[0024] The first data set that is generally input into the system and subsequently stored in a memory portion includes data representative of characteristics of the animal. Examples of types of data representative of animal characteristics ("animal data") include beginning

weight of the animal; a desired weight of the animal; an environment of the animal; a feed form; an actual or desired production level of the animal; and a relationship of animal muscle to fat of the animal. For example, the nutrient profile generated for a particular animal can vary based upon a number of different characteristics of the animal relating to one or more of its genotype, environment, current condition (e.g., defined in terms of health and/or weight), desired production level, feed form (e.g., meal or pellet), current production level, desired final condition (e.g., defined in terms of final weight and/or relationship of animal muscle to fat of the animal) and the like. Tables 1 and 2 below list illustrative sets of animal characteristics which can be used as a basis to generate nutritional profiles to be used in designing custom rations ("custom feeds") for swine and dairy cattle, respectively.

Table 1 Animal Characteristics Suitable for Generating a Nutritional Profile for a Feed for Swine

Animal Category Finisher

Gilt Replacement

- Grow

- Prebred

Sow

- Gestation

- Lactation

Artificial Insemination Boar

Begin Weight End Weight

Feed Disappearance (Intake)

Feed Wastage Feed Form Genotype (lean gain)

Effective Ambient Temperature

Temperature Draft

Bedding

% of pigs that are wet)

Pigs per pen

Pig density (square feet per pig)

Health

Flooring Type

Total pigs born/litter Litter weight gain

Total pigs born/litter

Table 2

Animal Characteristics Suitable for Generating a Nutritional Profile for Dairy Cattle

Target Milk Weight (volume)
Target Milk Butterfat %
Target Milk Protein %
Current Milk Weight (volume)
Current Milk Butterfat %
Current Milk Protein %
Percent of group in first lactation
Percent of group in second lactation

Body Weight
Body Weight Change
Body Condition Score (current)
Body Condition Score (desired)
Actual Dry Matter Intake
Environmental Temperature
Environmental Humidity
Genotype

[0025] The animal data representative of the characteristics of the animal may be inputted into a computer system with a memory portion available and configured to store the data. The animal data representative of the characteristics of the animal may be inputted into the system by a variety of methods known to those skilled in the art including a keyboard, mouse, touchpad, computer, internet or other related device.

[0026] The system includes a data processing circuit which is configured to generate profile data representative of a nutrient profile for the animals based upon the animal data. In effect, the nutrient profile is a description of the overall diet to be fed to the animals defined in terms of a set of nutritional parameters ("nutrients"). Depending on the desired degree of sophistication of the system, the profile data may include a relatively small set of amounts of nutrients or large number of amounts of nutrients. Table 3 includes an illustrative list of nutrients that may be used delineating profile data for animals such as pigs and dairy cattle. Of course, the list of nutrients used in generating profile data may differ for different types of livestock or other animals. Tables 4 and 5 respectively contain lists of nutrients suitable for use in generating nutritional profiles for swine and dairy cattle, respectively.

[0027] The data processing circuit in the present system is also configured to generate ration data representative of a combination of ingredients from one or more locations. The ration

data is generated by the data processing circuit based upon the profile data, feed data representative of the feed ingredients available at the location(s) and evaluation data representative of one or more evaluation criteria.

<u>Table 3</u> <u>Nutrients Suitable for Generating</u> a Nutritional Profile

Animal Fat
Ascorbic Acid
Biotin
Cal/Phos
Chloride
Choline
Chromium
Cobalt

Copper
Arginine (Total and/or Digestible)
Cystine (Total and/or Digestible)
Isoleucine (Total and/or Digestible)
Leucine (Total and/or Digestible)
Lysine (Total and/or Digestible)
Methionine (Total and/or Digestible)
Phenylalanine (Total and/or Digestible)
Threonine (Total and/or Digestible)
Tryptophan (Total and/or Digestible)

Valine (Total and/or Digestible)

Folic Acid
Phosphate
Iodine
Iron
Lactose
Lasalocid
Magnesium
Manganese
Monensin
Niacin
Potassium
Protein
Pyridoxine
Rh Index

Riboflavin Rough Ndf Rum Solsug Rumres Nfc Salt

Selenium
Simple Sugar
Sodium
Sol Rdp
Sulfur
Sw Obs Me
Thiamine
Total Rdp
Verified Adf

Verified Ash
Verified Calcium
Verified Dry Matt
Verified Fat
Verified Fiber
Verified Hemi
Verified Moisture
Verified Ndf
Verified Neg

Verified Nem
Verified Nfc
Verified Phos
Verified Protein
Verified Rup
Vitamin A
Vitamin B12
Vitamin B6
Vitamin D
Vitamin E
Vitamin K
Zinc

Verified Nel

Table 4 Nutrients Suitable for Generating a Nutritional Profile for Swine

Biotin
Cal/Phos
Choline
Coppr Add
Folic Acid
Iodine Add
Iron Add
Mang Add
Niacin
Pantotnc
Pyridoxine
Riboflavin
Salt

Selenium Add Sodium Sw Digphos

Thiamine

True Swine Digestible isoleucine True Swine Digestible lysine True Swine Digestible methionine True Swine Digestible threonine True Swine Digestible tryptophan True Swine Digestible valine

V Calcium V Phos V Protein Vit A Vit D Vit E Vit K

Vitamin B12 Zinc

Table 5 Nutrients Suitable for Generating a Nutritional Profile for Dairy Cattle

Acid Detergent Fiber Non-Protein Nitrogen

Biotin Phosphorus
Calcium Potassium
Chloride Protein

Cobalt Rumen Degradable Protein
Copper Rumen Undegraded Alanine

Dietary Cation Anion Difference Rumen Undegraded Histidine Digestible Neutral Detergent Fiber Rumen Undegraded Isoleucine

Dry Matter Rumen Undegraded Leucine
Fat Rumen Undegraded Lysine

Intestinally Digestible Arginine
Intestinally Digestible Histidine

Rumen Undegraded Methionine
Rumen Undegraded Phenylalanine

Intestinally Digestible Isoleucine

Intestinally Digestible Isoleucine

Rumen Undegraded Protein

Rumen Undegraded Protein

Intestinally Digestible Leucine Rumen Undegraded Tryptophan

Rumen Undegraded Valine

Intestinally Digestible Lysine Rumen Undegraded Valine
Intestinally Digestible Methionine Salt
Intestinally Digestible Phenylalanine Selenium

Intestinally Digestible Threonine Sodium
Intestinally Digestible Tryptophan Soluble Protein

Intestinally Digestible Valine Soluble Sugar Iodine Starch

Iodine Starch
Iron Sulfur

Magnesium Verified Net Energy for Lactation

Zinc

ManganeseVitamin ANeutral Detergent FiberVitamin DNeutral Detergent Fiber from RoughageVitamin E

Non Fiber Carbohydrates

Niacin

[0028] Evaluation criteria are typically related to factors representative of animal productivity and reflect an aspect of production a producer would like to optimize. The present system allows a producer to select evaluation criteria (e.g. cost/gain, cost/output, animal production rate, and/or feed/gain) which fits the producer's production goals. For example, a dairy producer may focus on the cost of feed required to produce a unit of output (cost/output), whereas a pork producer may focus on cost/gain or rate of gain.

[0029] Examples of suitable animal production criteria which may be used as evaluation criteria in the generation of ration data include (i) animal production rate, (ii) the cost of feed per unit animal weight gain, and (iii) the feed weight per unit animal weight gain. The animal production rate may simply be a measure representative of the rate of weight gain of the animal in question (rate of gain). For example, a pork producer may wish to optimize rate of gain by selecting a feed which maximizes the rate at which a pig gains weight. This could be selected if a pig farmer was interested in turning over production as quickly as possible in a fixed asset which has limited space. The evaluation data may include data representative of the cost of feed required to produce a unit of weight gain of the animal ("cost/gain" basis). For example, a pork producer may wish to optimize cost/gain by selecting a feed which minimizes the feed cost required to make a pig gain a unit of weight. The evaluation data can include data representative of the amount of feed required to produce a unit of gain (feed/gain). For example, a producer may wish to optimize the feed/gain by selecting a feed which minimizes the amount of feed required to produce a unit of gain. A producer might select this criterion if they were faced with feed storage space constraints.

[0030] Examples of other suitable animal production rates which may be used as an evaluation criteria include rates of production of food products, such as milk or eggs, from the animal. Other suitable evaluation criteria include the cost of feed required to produce a unit of output of a particular animal product ("cost/output"). For example, a milk producer may wish to optimize the cost/output by selecting a feed which minimizes the cost of feed required to produce a unit of milk. In addition to utilizing evaluation data representative of only a single evaluation criteria, the present system may be capable of using evaluation data representative of a combination of two or more evaluation criteria in generating the ration data. For example, when considering an appropriate feed, a producer may wish to generate a custom feed based on the rate of production as well as cost of the feed (typically on a cost/gain basis).

[0031] Furthermore, the producer may choose to weight the relative contributions of two or more evaluation criteria. The system may include a data processing circuit which generates ration data based in part upon a weighted average of more than one evaluation criteria. In one

specific embodiment, the system generates ration data based in part upon a 70:30 weighted average of two evaluation criteria (primary and secondary), such as a combination of cost of feed per unit animal weight gain and animal production rate. The system may also allow a user to alter the relative weighting accorded to the various evaluation criteria selected.

[0032] For instance, in the example referred to above, the producer may want to generate ration data using a combination of evaluation criteria that is weighted 70% on a cost/gain basis and 30% on a rate of animal weight gain basis. One method for providing such a weighted optimization analysis is to generate one solution for ration data using cost/gain as the sole evaluation criteria and generating a second for ration data using rate of animal weight gain as the sole evaluation criteria. Ration data which is representative of the weighted combined solution can be achieved by summing 70% of the amounts of ingredients from the cost/gain ration data set and 30% of the amounts of ingredients from the rate of gain ration data set. For example, in the instance where cost/gain ration data (generated solely on a cost/gain basis) includes 10% dehulled corn meal, and rate of gain ration data (generated solely on a rate of gain basis) includes 15% dehulled corn meal, if a producer chose cost/gain as the primary evaluation criteria the ingredient mix in the diet will include roughly 70% of the 10% dehulled corn meal requirement, and 30% of the 15% dehulled corn meal requirement summed to produce the amount of dehulled corn meal in the overall diet (i.e., circa 11.5% dehulled corn meal). This weighted summation is then repeated for all the amounts of ingredients present in the two custom diets generated by the two approaches. As one skilled in the art will recognize, there are other methods of generating ration data based on a weighted combination of evaluation criteria. The present system can also be configured to generate ration data based on other weightings of combinations of two or more evaluation criteria (e.g., two evaluation criteria weighted on either a 60:40 or 80:20 basis). In some embodiments of the present system, the weighting factors assigned to various evaluation criteria can themselves be input parameter(s) chosen by a producer to reflect the needs of his/her particular situation.

[0033] Figure 2 depicts the general flow of data in one embodiment of the present system. The system shown in Figure 2 includes a data processing circuit 30 configured to generate a

nutrient profile 32 based on the animal data 31 and optional adjustments which may be provided by a nutritionist. Other data processing circuits generate lists of nutrient amounts associated with individual ingredients available at an on-farm site 33 and manufacturing site 34. A data processing circuit 36, which includes a linear program generates a custom product based on evaluation criteria 35. The linear program typically also generates the custom product solution based on pricing data associated with both the on-farm and manufacturing site ingredients. In one embodiment, retail and wholesale pricing information may be normalized to allow the linear program to facilitate consideration of potential ingredients with different types of associated prices as the basis for a solution to a single multivariable problem. The linear program is a mathematical model capable of solving problems involving a large number of variables limited by constraints using linear math functions. A variety of different linear programs capable of solving problems of this type are known to those of skill in the art. One example of a program of this type is commercially available from Format International as part of computer software system for solving complicated multivariable problems.

[0034] Memory portions of the systems which store animal data, evaluation data, and feed data representative of on-hand ingredients and/or mill ingredients are in communication with a data processing unit capable of generating ration data. The data processing unit can include a data processing circuit or a digital processing circuit. The memory portions which store the animal data, feed data for on-hand and mill ingredients, and evaluation data may be in communication with the data processing unit by inputted keyboard commands, mouse commands, a network connection with another computer, personal data assistants, via a modem connection, via an internet, or via an intranet.

[0035] Data processing circuit(s) which include the linear program can take input data (e.g., profile data, feed data, evaluation data and ingredient constraint data) as a basis to compute ration data. Ration data includes data specifying a combination of ingredients solution which is solved to fulfill a desired nutrient profile based on one or more evaluation criteria. Ration data generated by the present system generally includes data representative of the types and amounts of ingredients to be used to provide an overall custom diet for an animal. The ration

data provided by the system generally also specifies a solution that is described in terms of a combination of types and amounts of ingredients from a first location (e.g., an on-farm location) and types and amounts of ingredients from at least one additional site (e.g., one or more supplier locations). Where the overall set of potential ingredients includes ingredients located at more than one location, the custom feed specified by the ration data may be made of ingredients located at either a single location or from more than one location. For example, the ration data may define a custom feed made up from ingredients located solely at supplier location or made up from ingredients located at both an on-farm location and a supplier location.

[0036] The ration data generally include custom feed data representative of a combination of amounts of the feed ingredients. The custom feed data may specify the type and corresponding amounts of the ingredients to be used in formulating the overall diet of an animal. This may be made up from a set of ingredients available at more than one location, e.g., from ingredients available at a producer's site and as well as ingredients available at a supplier location. The present system may also provide custom feed data which specifies the types and amounts of ingredients to be used from individual locations. For example, the custom feed data may include a listing of the types and amounts of ingredients available at a first location (e.g., on-farm ingredients) to be used to form a first feed mix and a listing of the types and amounts of ingredients available at a supplier location) to be used to form a second location (e.g., ingredients available at a supplier location) to be used to form a second feed mix. In such instances, the custom feed data will typically also specify the amounts of the first and second feed mixes that are to be used to make up the overall custom diet for an animal.

[0037] The ration data typically includes amounts of a variety of types of ingredients. The actual ingredients available at any particular location can vary over time and will generally vary on a regional basis as well as reflect the type of animal feed that is typically produced and/or stored at the particular site. Commonly, the ration data include feed data representative of amounts of ingredients from a number of different ingredient categories, such as a grain source, a protein source, a vitamin source, a mineral source (e.g., a macromineral source and/or a trace mineral source) and/or a fat source. Table 6 includes a

list of exemplary ingredients suitable for use in formulating custom feed mixes for a variety of animals. Tables 7, 8 and 9 include lists of ingredients which may be used in generating custom feed products for swine or dairy cattle.

Table 7 Ingredients Suitable for Use in Producing a Custom Feed for a Finishing Diet for Swine

Alimet
Bakery Product
Beet Pulp

Brewers Rice Brown Sugar

Calcium Carb
Cane Sugar

Canola Meal

Cereal Fines Cg Feed Choline

Copper Sulfate

Corn – Ground Fine Corn Gluten Meal

Corn Oil Corn Starch

Dehydrated Alfalfa

Distillers Grains With Soil

Dried Potato Waste

Dynasol Fat

Fat Sprayed Feather Meal Feeding Rate Fish Meal Linseed Meal L-Lysine HCl Lt. Barley L-Threonine

Malt Sprouts

Meat And Bone Meal Menhaden Fish

Meilliauell I

Molasses

Mono-Dical Phos Monosod Phos

Oat Mill Byproducts
Oat Mill Byproducts

Oats – Ground Oats – Rolled Pork Bloodmeal Safflower Meal

Salt
Selenium
Soybean Hulls
Soybean Meal
Soybean Oil
Sunflower
Tryptosin
Wheat Midds

Table 8 Ingredients Suitable for Use in Producing a Custom Feed for Breeding Swine

Alimet Methionine
Animal Fat Mineral Oil
Ascorb Acid Molasses-Cane

Bakery Product Mono-Dicalcium Phosphate

Bentonite Oat Hulls
Blood Meal - Beef/Pork Red Flavor
Calcium Carbonate Rice Bran
Cereal Fines Salt
Choline Chloride Selenium
Copper Sulfate Soybean Hulls
Corn Germ Meal Threonine

Corn Germ Meal

Corn Gluten Feed

Distillers Grains With Solubles

Dry Methionine Hydroxy Analog

Fish Meal

Malt Sprouts

Threonine

Tryptophan

Vitamin E

Wheat Midds

Wheat Starch

Zinc Oxide

Meat And Bone Meal; Pork Carcass

Table 9
Ingredients Suitable for Producing
a Custom Feed for Dairy Cattle

Zinc Sulfate

a Custom Feed for Dairy Cattle
Calcium Carbonate Salt

Copper Sulfate Selenium

Corn Gluten Meal Sodium Sesquicarbonate

Fat Soybean Hulls

Magnesium Oxide Soybean Meal

Meat And Bone Meal, Pork Trace Minerals

Mono-Dical Phos Urea

Niacin Vitamin-E

Pork Blood Meal Wheat Midds

K/Mg/Sulfate Zin-Pro

Yeast

[0038] When feeding animals, producers may not be able to satisfy nutritional requirements of the animals solely using on-hand ingredients (e.g., on-farm ingredients). To satisfy the animal's nutritional requirements, producers may desire to use on-hand ingredients in conjunction with a custom feed product made up of feed ingredients available from an outside supplier, such as a mill, feed mixer, and the like. The outside supplier will commonly have a range of ingredients available or on hand in their inventory (e.g., corn in various forms, soybean meal, wheat mids, barley, oats, animal fat, various vitamin supplements).

[0039] In addition to data specifying the types and amounts of ingredients to be used to provide the overall custom diet for an animal, the ration data generated by the present system can also include other data associated with the overall custom diet. Examples of such other data include cost data representative of a cost associated with the custom feed data, feed weight data representative of a feed weight associated with the custom feed data, and performance data representative of projected animal performance associated with the custom feed data. For example, Table 10 below lists a number of categories of ration data that may be useful in assisting a producer and/or supplier in evaluating a custom feed with respect to productivity, animal performance and cost effectiveness. The availability of these types of information can provide a producer and/or supplier with additional information concerning the effects of variations in dietary composition on factors such as cost, volume of feed, wastage and animal performance. As with the listing(s) of the types and amounts of ingredients, the cost data and feed weight data can be representative of costs and feed weights associated with the overall custom diet and/or with feed mix(es) to be provided from individual locations.

Table 10 Illustrative Categories of Ration Data Associated with a Custom Feed for Swine

End Weight
Days in Phase
Avg Daily Gain
Avg Daily Feed Intake
Total Feed Consumed
Feed/Gain

Lean Gain
Lean %
Effective Ambient Temp
Cost of Gain
Total Cost per phase

[0040] In other variations of the embodiments described herein, the systems and/or methods may also include a memory portion in communication with the digital processor which stores variation data representative of a range for one or more nutrient components of the nutrient profile. The digital processor is capable of generating a set of ration data based upon the variation data. The memory portion may store variation data which correspond to preselected incremental variations for the values assigned to one or more individual nutrients in the nutritional profile. For example, memory portion may store variation data which correspond to preselected incremental positive and negative variations of the values assigned to two individual nutrients, such as true digestible lysine and net energy. The digital processor would generate ration data corresponding to each of the eight possible additional combinations of values for the two specified nutrients. Together with the ration data associated with the original nutritional profile, the resulting set of nine ration data corresponding to the various combinations of values for each specified nutrient (original value, original value plus an increment; original value minus an increment) would make up a three by three matrix of ration data. One example of this approach is illustrated in Table 11 below. A general approach to generating a set of ration data based upon variation data is depicted schematically in Figure 3. The determination of ration data for the center point in the matrix ("Ration Data 5") corresponds to the solution generated by the data processing circuit based on the nutrient profile. In the example shown in Table 11, the nutrient profile has values of 0.90% for true digestible lysine and 2150 kcal/kg for net energy. Each of the

eight other ration data in the set depicted in Table 11 corresponds to a ration data generated for a modified nutrient profile in which the value for at least one nutrient has been varied by a specified increment. For example, Ration Data 1 represents ration data associated with a modified nutrient profile has values of 0.95% for true digestible lysine and 2100 kcal/kg for net energy. Ration Data 6 represents ration data associated with a modified nutrient profile in which only the value for true digestible lysine (0.85%) has been varied from the values in the nutrient profile. The generation of such a matrix can facilitate an evaluation of the effect of incremental variations in amounts of specified nutrient(s) on the assessment of optimum ration data for a given evaluation criteria.

Table 11
True Digestible Lysine

		0.95%	0.90%	0.85%
Net <u>Energy</u> (kcal/kg)	2100	Ration Data 1	Ration Data 2	Ration Data 3
	2150	Ration Data 4	Ration Data 5	Ration Data 6
	2200	Ration Data 7	Ration Data 8	Ration Data 9

[0041] The invention has been described with reference to various specific and illustrative embodiments and techniques. However, it should be understood that many variations and modifications may be made while remaining within the spirit and scope of the invention.

Corn Residue

Corn/Sugar Blend

Corn Starch

Table 6

Exemplary Ingredients Suitable for Use in Formulating Custom Feed Mixes

Cobalt **Acidulated Soap Stocks Beet** Active Dry Yeast Beet Pulp Cobalt Carbonate Cobalt Sulfate Alfalfa Meal **Biotin** Cocoa Cake Alfalfa-Dehydrated **Biscuit By Product** Black Beans Cocoa Hulls Alimet Alka Culture Blood-Flash Dry Copper Oxide Copper Sulfate Alkaten Blueprint Rx Almond Hulls Bone Meal Corn Chips **Brewers Rice** Corn Chops Ammonium Chloride Corn Coarse Cracked Ammonium Lignin Brix Cane Ammonium Buckwheat Corn- Coarse Ground Polyphosphate Corn Cob-Ground **Bugs** Ammonium Sulfate Cage Calcium Corn Distillers Corn Flint Calcium Cake Amprol Amprol Ethopaba Calcium Chloride Corn Flour Anhydrous Ammonia Calcium Formate Corn Germ Bran Appetein Calcium Iodate Corn Germ Meal Apramycin Calcium Sulfate Corn Gluten Arsanilic Acid Calciun Prop Corn- High Oil Corn Kiblets Ascorb Acid Calf Manna

Aspen Bedding Canadian Peas Corn Meal Dehulled
Availa Cane-Whey Corn Oil

Availa Cane-Whey
Avizyme Canola Cake
Bacitracin Zinc Canola Fines
Bakery Product Canola Meal
Barley Canola Oil

Barley Corn-Cracked Barley-Crimped Canola Oil Blender Corn-Crimped Barley-Ground Corn-Ground Fine Canola Oil Mix Barley-Hulless Canola Screenings Corn-Ground Roasted Barley-Hulls Canola-Whole Corn-Steam Flaked Barley-Midds Carbadox Corn-Steamed

Barley-Needles Carob Germ Corn-Whole
Barley-Rolled Carob Meal Cottonseed Culled
Barley-St. Bon. Cashew Nut By Product Cottonseed Hull
Barley-Whole Catfish Offal Meal Cottonseed Meal

Barley-With Enzyme Choline Chloride Cottonseed Oil
Baymag Chromium Tripicolinate Cottonseed Whole

Beef Peanut Hulls Citrus Pulp Coumaphos
Beef Peanut Meal Clopidol Culled Beans

Table 6 – (Continued)

Danish FishmealHemicellulose ExtractMolassesDecoquinateHempMolasses BlendDextroseHerring MealMolasses Dried

Diamond V Yeast Hominy Molasses Standard Beet
Disodium Phosphate Hygromycin Molasses Standard Cane
Distillers Grains Indian Soybean Meal Molasses-Pellet

Distillers Grains Indian Soybean Meal Molasses-F
Dried Apple Pomace Iron Oxide-Red Mold
Dried Brewers Yeast Iron-Oxide Yellow Monensin

Dried Distillers Milo

Dried Porcine

Kapok Seed Meal

Dried Whole Milk

Powder

Monosodium Phos

Monosodium Glutamate

Monosodium Phosphate

Mung Bean Hulls

Powder Kem Wet Mung Bean Hulls
Duralass Lactose Mustard Meal High Fat

Enzyme Booster Larvadex Mustard Oil
Epsom Salts Lasalocid Mustard Shorts
Erythromycin Levams Hel Narasin

Extruded GrainLimestoneNatuphosExtruded Soy FlourLincoNiacinFatLincomixNicarbazinFeather MealLincomycinNitarsone

Feeding Oatmeal Linseed Meal Oat Cullets
Fenbendazole Liquid Fish Solubles Oat Flour
Fermacto Lupins Oat Groats
Ferric Chloride Lysine Oat Hulls

Ferrou Cabonate Magnesium Oat Mill Byproducts
Ferrous Carbonate Magnesium Sulfate Oat Screenings
Ferrous Sulfate Malt Plant By-Products Oat Whole Cereal

Fine Job's Tear Bran Manganous Ox Oatmill Feed
Fish Meal Maple Flavor Oats Flaked
Fish Masonex Oats-Ground
Flavoring Meat And Bone Meal Oats-Hulless

Folic Acid Meat And Bone Meal Oats-Premium
French Fry Rejects Meat Meal Oats-Rolled
Fresh Arome Mepron Oats-Whole
Fried Wheat Noodles Methionine Oyster Shell
Gold Dye Millet Screenings Paddy Rice

Gold Flavor Millet White Palm Kernel
Grain Dust Millet-Ground Papain
Grain Screening Milo Binder Papain Enzyme

Granite Grit Milo-Coarse Ground Paprika Spent Meal
Grape Pomace Milo-Cracked Parboiled Broken Rice
Green Dye Milo-Whole Pea By-Product

Green Flavor Mineral Flavor Pea By-Froduct
Green Flavor Mineral Flavor Pea Flour
Guar Gum Mineral Oil Peanut Meal
Hard Shell Mixed Blood Meal Peanut Skins

Table 6 – (Continued)

Pelcote Dusting
Phosphate
Phosphoric Acid
Phosphorus

Phosphorus Defluorinated

Pig Nectar Plant Waste Poloxalene Popcom

Popcom Screenings Porcine Plasma; Dried Pork Bloodmeal

Porzyme Posistac

Potassium Bicarbonate Potassium Carbonate Potassium Magnesium

Sulfate

Potassium Sulfate Potato Chips

Poultry Blood/Feather

Meal

Poultry Blood Meal Poultry Byproduct Predispersed Clay

Probios

Procain Penicillen Propionic Acid Propylene Glycol

Pyran Tart Pyridoxine Quest Anise Rabon

Rapeseed Meal Red Flavor Red Millet Riboflavin Rice Bran

Rice By-Products

Fractions
Rice Dust
Rice Ground
Rice Hulls

Rice Mill By-Product Rice Rejects Ground Roxarsone Rumen Paunch Rumensin Rye

Rye Distillers
Rye With Enzymes

Safflower Meal
Safflower Oil
Safflower Seed
Sago Meal
Salinomycin

Salt

Scallop Meal Seaweed Meal Selenium Shell Aid

Shrimp Byproduct

Silkworms Sipernate

Sodium Acetate Sodium Benzoate

Sodium Bicarbonate Sodium Molybdate

Sodium Sesquicarbonate Sodium Sulfate

Solulac Soweena

Soy Flour Soy Pass

Soy Protein Concentrate

Soybean Cake

Soybean Curd By-Product

Soybean Dehulled Milk By-Product

Soybean Hulls Soybean Mill Run Soybean Oil Soybean Residue

Soybeans Extruded Soybeans-Roasted Soycorn Extruded Spray Dried Egg

Standard Micro Premix

Starch Molasses

Steam Flaked Corn

Steam Flaked Wheat

Sugar (Cane)
Sulfamex-Ormeto

Sulfur Sulfur

Sunflower Meal Sunflower Seed Tallow Fancy Tallow-Die Tallow-Mixer Tapioca Meal Tapioca Promeance

Taurine
Terramycin
Thiabenzol
Thiamine Mono

Threonine
Tiamulin
Tilmicosin
Tomato Pomace
Trace Min

Tricalcium Phosphate

Triticale
Tryptophan
Tryptosine
Tuna Offal Meal

Tylan Tylosin Urea

Vegetable Oil Blend Virginiamycin

Vitamin A

Vitamin B Complex

Vitamin B12 Vitamin D3 Vitamin E Walnut Meal Wheat Bran

Wheat Coarse Ground Wheat Germ Meal Wheat Gluten

Wheat Meal Shredded

Wheat Millrun
Wheat Mix

Wheat Noodles Low Fat

Table 6 - (Continued)

Wheat Red Dog

Wheat Starch

Wheat Straw

Wheat With Enzyme

Wheat-Ground

Wheat-Rolled

Wheat-Whole

Whey Dried

Whey Permeate

Whey Protein

Concentrate

Whey-Product Dried

Yeast Brewer Dried

Yeast Sugar Cane

Zinc

Zinc Oxide

Zoalene